International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 05 | May-2018 www.irjet.net p-ISSN: 2395-0072

A review paper on Vapor absorption system working on LiBr/H2O

M.N Karimi[1], Ashfaque Ahmad[2], Sadia Aman[3], M.D Jamshed Khan[4]

[1,2,3,4] *Department of Mechanical Engineering, Faculty of Engineering and Technology, Jamia Millia Islamia, New Delhi-110025, India*

Abstract- For the rapid growth and development of the countries there has been continues demand of energies. These energies are generally meet with burning of fossil fuels which has led to global warming. So for meeting the huge demand of Refrigeration and air conditioning at large scale Vapor absorption system working on Lithium Bromide and water is used. Solar energy and Waste heat from industries are the most favorable options because these sources do not degrade the environment anyway. The research work done on VAS working on $LiBr/H_2O$ for cooling purpose is based on First and Second Law of thermodynamics has been done in context of one of its major component Generator. The researchers have tried to find out the optimum COP of the system varying the different parameters affecting its performance. They found that Generator temperature has highest influence on the COP of the system. The research work has been categorized into two groups: Energy analysis and Exergy analysis. A brief description of literature reviews and their findings has been tabulated under.

Keyword: Refrigeration, Exergy, Energy, Generator.

1.0 Introduction

VAS is a substitute to vapor compression cycle. There are two major working pairs on which cycle works they are namely NH_3/H_2O and $LiBr/H_2O$. Here in this paper work on $LiBr/H_2O$ is done. A vapor absorption refrigeration system working on $LiBr/H_2O$, H_2O is used as refrigerant and a solution of lithium bromide in water is used as absorbent. Since water is used as refrigerant, using these systems it is not possible to provide refrigeration at below zero temperatures. Hence it is used only in applications requiring refrigeration at temperatures above 0˚C. Since these systems run on low-grade thermal energy they are preferred when low-grade energy such as waste heat or solar energy is available. Absorption systems use natural refrigerants such as water and lithium bromide. They are environment friendly unlike Vapor compression cycle.

An extensive literature review has been done on the vapor absorption refrigeration system working on $LiBr/H_2O$ as a working pair. There has been continues effort made in the various papers for the better design and working of the VAS components so that optimum efficiency of the cycle working on this working pair can be achieved. This literature review provides clear insight of the studies and development made in the field of VAS working on LiBr and water. There are numerous papers on energy and exergy analysis. Energy analysis tells the total losses associated with the components. Exergy helps in finding the work potential of the component. It indicates the irreversibility associated within the components. In order to understand the various losses in the major components of VAS many approaches has been made with help of exergy analysis, performance of the major components has been analyzed using concept of exergy loss and major losses are found to occurs in the Absorber and Generator. Absorber and Generator are more sensitive to variation in the temperature. Considering the fact an optimum Generator temperature can be found out which will produce optimum COP of the cycle.

2.0 Energy analysis of VAS and its effect on Generator

The basic thermodynamic analysis is the Energy analysis for any system. Energy analysis helps to find out the major loss incurring component. In order to reduce those losses many attempts has been made so that COP of the cycle can be increased. Energy from external source is given in Generator so generator temperature is found to play an important role in COP of the cycle. The literature reviews incorporating energy analysis and its effect has been discussed below.

A. Bell et al (1996) they developed an experimental absorption cooling system working on LiBr/H2O, driven by solar energy. All the components of the VAS were placed in evacuated glass cylinders to observe all the processes. They found the thermodynamic performance of the system incorporating energy balance for all the components. They arrived to the result that the performance of the cycle depends on generator temperature and so there exist an optimum generator temperature at which COP is Maximum. They also concluded that when the system was operated at low condenser and low absorber temperatures a reliable COP is obtained at a generator temperature as low as 68C.W. Rivera et al (1999) Experimental evaluation of a single-stage heat transformer (SSHT) operating with the water/Carrol mixture. The experimental work was

done using the water and Carrol mixture (LiBr and ethylene glycol [(CH2OH)2)] in the ratio 1:4.5 by weight. Flow ratios, gross temperature lift (GTL), useful heat, COP was plotted Vs temperature and concentration. The water/Carrol mixture has higher solubility than water and lithium bromide. High experimental values are obtained for the gross temperature lift, it is a preferred mixture.

Shun-Fu Lee and S. A. Sheriff (2000) have done the thermodynamic analysis of a lithium bromide/water absorption system for cooling and heating applications. Performance and simulations have been carried out. The effect of only heat source temperature was evaluated on COP and Exergetic efficiency. In the parametric analysis of the absorption system for cooling with varying operating conditions, it was clear that a low cooling water temperature yields both a higher cooling COP and higher exergetic efficiency as expected. Increasing the heat source temperature can improve the COP of the system, but as the heat source temperature increases beyond a certain limit COP of the system decreases. This is the negative effect of increasing the heat source temperature.

M.B Arun et al (2001) they did the Performance comparison of double effect parallel flow and series flow LiBr and H2O absorption systems. Their analysis was based on the concept of equilibrium temperature at low generator pressure.COP and its sensitivity to operating conditions was compared with those of series flow cycle. COP of parallel flow system is more sensitive to evaporator temperature variation and less sensitive to condenser and absorber External heat input at the LP generator has greater impact on the parallel flow system than on the series flow. G.A Florides et al (2002) done the modeling and simulation of solar absorption cooling system is done. The system is modeled with TRNSYS simulation program. System optimization is carried out in order to select the appropriate type of collector, optimum size of storage tank, optimum collector slope and area. The collector area is determined by performing the life cycle analysis of the system. Although all the findings are done for a particular conditions but the similar result can be obtained with higher solar availability. Y. Kaita (2002) Simulation results of triple-effect absorption cycles was analyzed. Simulation analysis was done for three kinds of triple-effect absorption cycles they are: parallel flow, series flow, reverse flow. Using a simulation program COP, maximum pressure and maximum temperature of each cycle were calculated. The sensitivity analysis of each component was also done. The results show that parallel flow cycle had maximum COP. The maximum pressure and temperature in the reverse flow cycle are lower than other cycles.

G.A Florides (2003) they designed and constructed a setup of a LiBr and absorption machine. The necessary heat and mass transfer equations and appropriate equations describing the properties of the working fluids are specified. These equations are employed in computer program, and a sensitivity analysis is performed. The analysis shows for greater difference between the absorber LiBr inlet and outlet percentage ratio, the smaller will be mass circulation in the absorber. COP of the unit is lowered when the generator temperature is increased resulting in increases in the generator pressure. Antonio De Lucas et al (2004) Experimental investigation of a vapor absorption refrigeration system is done. The Performance evaluation and simulation of a new absorbent for an absorption refrigeration system was done. New absorbent used is a mixture of lithium bromide and potassium formate (HCO2K) in the ratio of 2:1 w/w. They concluded that the energy requirement in the generator was less. The waste heat at temperature of 328K is sufficient to boil the diluted absorbent mixture.

Marina Donate et al (2006) thermodynamic evaluation of new absorbent mixtures of LiBr and organic salts of sodium and potassium (formate, acetates and lactates) for absorption refrigeration machines was done. The objective was to overcome the limitations of LiBr, improve its characteristics and increase the efficiency of the cycle. The properties such as Density, viscosity, enthalpies of dilution, solubility and vapor pressure are the data for the proposed mixtures have been measured. A Simulation program was developed to evaluate temperatures, heats exchanged in the different sections and the efficiency of the cycle. Omer Kaynakli et al (2007) Theoretical study on the effect of operating conditions on performance of absorption refrigeration system was completed. With the help of first and second law of thermodynamics analyzed the performance of a single stage lithium bromide and water absorption refrigeration system on varying certain working parameters. Analysis on LiBr and water absorption refrigeration cycle is performed. The influences of operating temperature and effectiveness of heat exchanger on the thermal loads of components, COP and efficiency ratio are investigated. The thermal loads on the absorber and generator decrease, as the generator and evaporator temperature Increases .The decrease of the generator thermal load increases the COP.

Francis A gyenim et al (2010) They Designed and done the Experimental testing of the performance of an outdoor LiBr and H2O thermal absorption cooling system. A domestic scale prototype experimental solar cooling system was developed based on a LiBr/H2O absorption system and tested. The system consisted of a 12m2 vacuum tube solar collector, 4.5 kW LiBr/ H2O

absorption chiller, a 1000 Liter cold storage tank and 6 kW fan coil. The system performance as well as the performances of the individual components of the system was evaluated based on the physical measurements of the daily solar radiation, ambient temperature, inlet and outlet fluid temperatures, mass flow rates and electrical consumption by component. Experimental results prove the feasibility of the new concept of cold store at this scale, with chilled water temperatures as low as 7.4°C demonstrating its potential application in cooling domestic scale buildings. L. Garousi et al (2011) they did the Analysis of crystallization risk in double effect absorption refrigeration systems. A computational model was developed using EES software to study and compare the effects of operating parameters on crystallization phenomena in three classes of double effect lithium bromide and water VAS they are: series parallel and reverse parallel with identical refrigeration capacities. They concluded that the range of operating conditions without crystallization risks in the parallel and the reverse parallel configurations is wider than those of the series flow system. In other words, series flow systems are more prone to crystallization. It is found that, in series flow systems, the possibility of crystallization increases with increasing THPG, TEVA and effectiveness of the LTHE and decreasing TCOND.

Saed Sedigh et al (2012) Thermodynamic analysis of triple effect absorption refrigeration system is done. The cycle was analyzed based on the first and second laws of thermodynamics. The Triple effect cycles have not yet been utilized in industries and the research continues on these cycles. In this paper, a triple effect parallel flow LiBr and water absorption chiller is thermodynamically analyzed. It is seen that with the increase of the temperatures of evaporator, condenser, absorber and HTG, COP of the system increases and with the decrease of condenser temperature, COP decreases. The triple effect LiBr absorption chiller has a higher COP compared to the single and double effect chillers. Zeyu Li, Jinping Liu (2015) this paper mainly deals with the appropriate heat load ratio of generator of air cooled LiBr and H2O double effect absorption chiller. Four type systems named: series, pre-parallel, rear parallel and reverse parallel flow configuration were considered. The corresponding parametric model was developed to analyze the comprehensive effect of heat load ratio of generator on COP and risk of crystallization. The result shows that COP goes up linearly with the decrease of heat load ratio of generator. The risk of crystallization also rises slowly at first but increases fast gradually. A.A.V. Ochoa et al (2016) Dynamic study of a single effect absorption chiller using the pair LiBr and H2O. A mathematical model was developed based on conservation of mass, energy, and Species, which considers the correlations of the convective coefficients of absorption refrigeration process. The implementation of this mathematical model was built on the Mat Lab platform. The model has the ability to simulate and predict the behavior of internal and external parameters such as temperature, concentration and pressures when these are subjected to disruptions in the power supply and thermal load. The model makes it possible to understand and deduce other information about its behavior. Like increasing the temperature of the hot water in the chiller not necessarily lead to, increase in the COP of the system. Zeyu Lia et al (2016) paper mainly deals with the variation of heat load ratio of generator (HLRG) with the working condition as well as corresponding design criterion. Four type double effect chillers named series, pre parallel, rear parallel and reverse parallel flow system were considered. The parametric model
was developed the introduction of new thermodynamic relationship of generator.

2.1 Table -1 Summary of Literature Review on Energy analysis

S.NO	AUTHORS	DESCRIPTION	YEAR	METHODOLOGY	FINDINGS
1	A.Bell, J-Al-Daini, Habib AL-Ali, R.G.Abdel Gayed, and Duckers.	The design of an evaporator/absorber and thermodynamic analysis of a vapor absorption chiller driven by solar energy.	1996	An experimental setup of cooling system working on LiBr/H2O, driven by solar energy. The energy balance approach for all the components of VAS is done	Performance of the cycle depends on the generator temperature and so there exist an optimum generator temperature at which COP is Maximum.
2	W. Riveraa, R.J. Romeroa, R. Besta, C.L. Heard	Experimental evaluation of a single-stage heat transformer (SSHT) operating with the water/Carrol mixture.	1999	The experimental work was done using the water and Carrol mixture (LiBr and ethylene glycol [(CH2OH)2)] in the ratio 1:4.5 by weight. Flow ratios, gross temperature lift (GTL)	The water/Carrol mixture has higher solubility than water and lithium bromide. GTL increases with an increase in the solution concentration and reaches 52°C for the greatest concentration.
3	Shun-Fu Lee and S. A. Sherif	Thermodynamic analysis of a lithium bromide/water absorption system for cooling and heating applications.	2000	Performance and simulations have been carried out. Second law analysis on single effect LiBr and H2O absorption refrigeration system. The effect of only heat source temperature on COP and Exergetic efficiency.	Low cooling water temperature yields both a higher cooling COP and higher exergetic efficiency.Increasing the heat source temperature improves the COP but beyond a certain limit COP decreases. This is the negative effect of increasing the heat source temperature.

4	M.B Arun, M.P Maiya, S.Srinivasa Murthy	Performance comparison of double effect parallel flow and series flow LiBr and H2O absorption systems.	2001	Analysis based on the concept of equilibrium temperature at low pressure generator.COP and its sensitivity to operating conditions was compared with those of series flow cycle.	COP of double effect parallel flow system is greater than that of series flow system in the usual range of operating conditions. COP of parallel flow system is more sensitive to TE less sensitive to TC and TA.
5	G.A Florides S.A. Kalogiru S.A.Tassou , L.C.Wrobel.	Modeling and simulation of an absorption solar cooling system.	2002	The system is modeled with TRNSYS simulation program. System optimization is carried out in order to select the appropriate type of collector, Slope, Area and optimum size of storage tank.	For a typical house at temperature of 25°C and cooling load of 78MJ, the final optimum system consists of a 15 m2 compound parabolic collector tilted at 30 degree from the horizontal. A similar result can be obtained with higher solar availability.
6	Y.Kaita	Simulation results of triple-effect absorption cycles. Simulation analysis was done for three kinds of triple-effect absorption cycles they are: parallel series, reverse flow.	2002	Using a simulation program COP, maximum pressure and maximum temperature of each cycle were calculated. The sensitivity analysis of each component was also done.	The results show that parallel flow cycle had maximum COP. The maximum pressure and temperature in the reverse flow cycle are lower than other cycles.
7	G.A Florides S.A Kalogirou S.A. Tassou L.C.Wrobel	Design and construction of a LiBr and absorption machine	2003	The necessary heat and mass transfer equations and appropriate equations describing the properties of the working fluids are specified. These equations are employed in computer program, and a sensitivity analysis is performed.	For greater difference between the absorber LiBr inlet and outlet percentage ratio, the smaller will be mass circulation in the absorber. COP of the unit is lowered when the generator temperature is increased. Greater the heat exchanger area, greater the efficiency.
8	Antonio De Lucas, Marine Donate, Carolina Molero.	Experimental investigation of a vapor absorption refrigeration system.	2004	Performance evaluation and simulation of a new absorbent for an absorption refrigeration system. New absorbent used is a mixture of lithium bromide and potassium formate (HCO2K) in the ratio of 2:1 w/w	Energy requirement in the generator was less. The waste heat at temperature of 328K is sufficient to boil the diluted absorbent mixture. The efficiency of cycle was increased, new absorbent was less corrosive in nature, less expensive to manufacture.
9	Marina Donate, Rodriguez, Antonio De Lucas, Juan F. Rodrıguez	Thermodynamic evaluation of new absorbent mixtures of LiBr and organic salts of sodium and potassium (formate, acetates and lactates) for absorption refrigeration machines.	2006	The properties such as Density, viscosity, enthalpy of dilution, solubility and vapor pressure for the proposed mixtures have been measured. A Simulation program was developed to evaluate temperatures, heats exchanged.	The optimum proportion of new mixture is LiBr: salt=2:1 because it presents a low value of heat of dilution. This value implies that requirement of heat in the generator is lower. The heating requirement in the generator was drastically decreased using this mixture.
10	Omer Kaynakli, Muhsin Kilic	Theoretical study on the effect of operating conditions on performance of VAS. With the help of first and second law of thermodynamics analyzed the performance of a single stage LiBr/H2O system.	2007	The influences of operating temperature and effectiveness of heat exchanger on the thermal loads of components, COP and efficiency ratio (g) are investigated.	The thermal loads on the absorber and generator decrease, as the generator and evaporator temperature Increases. The decrease of the generator thermal load increases the COP.
11	Francis Agyenim, Ian Knight, M.Rhodes	Design and experimental testing of the performance of an outdoor LiBr and H2O thermal absorption cooling system.	2010	A domestic scale prototype experimental solar cooling system was developed based on a LiBr/H2O absorption system and tested. The system performance as well as of individual components of the system was evaluated.	The system produced an electrical COP of 3.6. Experimental results prove the feasibility of the new concept of cold store at this scale, with chilled water temperatures as low as 7.4C demonstrating its potential. The average thermal COP of the system was 0.58.
12	L.Garousi Farshi S.M. Seyed Mahmoudi, M.A. Rosen	Analysis of crystallization risk in double effect absorption refrigeration systems	2011	A computational model was developed using EES software to study and compare the effects of operating parameters on crystallization phenomena in series ad parallel flow.	Operating range for parallel and the reverse parallel configurations is wider than those of the series flow system. Series flow systems are more prone to crystallization.
13	Saed.Sedigh, Hamid Saffari .	Thermodynamic analysis of triple effect absorption refrigeration system.	2012	The cycle was analyzed based on the first and second laws of thermodynamics. Triple effect parallel flow LiBr and water absorption chiller is thermodynamically analyzed.	It is seen that with the increase of the temperatures of evaporator, condenser, absorber and HTG, COP of the system increases and with the decrease of condenser temperature, COP decreases.
14	Zeyu Li, Jinping Liu	Appropriate heat load ratio of generator for different types of air cooled LiBr and H2O double effect absorption chiller.	2015	Heat load ratio of generator of air cooled LiBr and H2O double effect absorption chiller. Parametric model was developed to analyze the effect of heat load ratio of generator on COP and risk of crystallization.	COP goes up linearly with the decrease of heat load ratio of generator. The risk of crystallization also rises slowly at first but increases fast gradually.

15	A.A.V. Ochoa, J.C.C. Dutra, J.R.G. Henríquez, C.A.C. dos Santos	Dynamic study of a single effect absorption chiller using the pair LiBr/H2O.	2016	A mathematical model was developed based on conservation of mass, energy, and Species. The implementation of a mathematical model was built on the Mat Lab platform.	The model makes it possible to understand and deduce Other information about its behavior. Like increasing the temperature of the hot water in the chiller not necessarily lead to, increase in the COP of the system.
16	Zeyu Lia, Liming Liua, Jinping Liua	Variation and design criterion of heat load ratio of generator for Air cooled lithium bromide-water double effect absorption system.	2016	The parametric model was developed by the introduction of new thermodynamic relationship of generator. The change of HLRG for different type chillers with working condition was analyzed.	The HLRG goes down quadratically with the increase of HPG temperature. It reduces linearly with the rise of TE as well as effectiveness of HTHE. However, the HLRG goes up quadratically with the rise of surrounding temperature.
17	Salem M. Osta-Omar and Christopher Micallef	Determination of Concentration of the Aqueous LiBr Solution in a VAS by Measurement of Electrical Conductivity and Temperature.	2017	Developed an empirical equation for calculating the concentration of the aqueous LiBr solution during the operation of the system when the electrical conductivity and temperature of solution are known.	Method is accurate and efficient way to determine the concentration of aqueous LiBr solution in the vapor absorption refrigeration system. An empirical equation to determine the concentration of the aqueous LiBr solution was also presented.

3.0 Exergy analysis of VAS and its effect on Generator

Exergy analysis approach has been adopted in many research papers. It helps in finding the work potential of the components of VAS. It measures the amount of irreversibility occurring in the components. Exergy analysis had been done to major components such as absorber and generator. It is found that major irreversibility occur in the absorber and the generator. Generator is most sensitive to change in the temperature. All those papers containing exergy analysis is review and mentioned below.

S. Bahar et al (1997) The design and optimization of an absorption refrigeration system operated by solar energy. The effect of variation of temperatures on different component of VAS for a given Refrigeration capacity has been studied. Flow ratios, gross temperature lift (GTL), useful heat, COP was plotted Vs temperature and concentration.

Ravi kumar et al (1998) Exergy analysis of solar assisted double effect absorption refrigeration system. Detailed study of exergy variation in the solar assisted absorption system is analyzed. Cycle parameters are analyzed on the basis of basis first law and second law of thermodynamics. The quality of the devices decline the availability of the device varies linearly. The availability across Evaporator, Condenser and Absorber changes the cycle condition and produces a corresponding change in the generator availability. Arzu Sencana et al (2005) Exergy analysis of a single effect lithium bromide and water absorption refrigeration system was done. They calculated the Exergy losses in the system components. The effect of heat source temperature on COP and Exergetic efficiency was computed. They concluded that the cooling and heating COP of the system increases slightly when increasing the heat source temperature but the Exergetic efficiency of the system decreases, when the heat source temperature increase for both cooling and heating applications. The condenser and Evaporator heat loads and exergy losses are less than those of generator and absorber. This is due to heat of mixing in the solution which Is not present in the pure fluid.

Muhsin Kilic and Omer Kaynakli (2007) Second law-based thermodynamic analysis of water- lithium bromide absorption refrigeration system. Calculated single effect and series flow double effect vapor absorption systems using energy analysis approach. The effect of different parameters such as generator temperature, absorber temperature, condenser temperature, solution circulation ratio and solution concentration etc had been investigated by these researchers on COP. The results show that COP of the cycle increases with increasing generator and Evaporator temperatures, but decreases when condenser and absorber temperature increases.

Ribah Gomri, and Riad Hakimi (2008) To simulate the refrigeration system by using a computer, a new set of computationally efficient Formulations of thermodynamic properties of LiBr and water solution developed is used. The exergy analysis is carried out for each component of the system. All exergy losses that exist in double Effect LiBr and water absorption system are calculated. In addition to this COP and the exergetic efficiency of the system are also calculated. Result shows that performance of the system increases with increase in low pressure Generator (LPG) temperature, but decreases with increasing high pressure generator (HPG) temperature. The maximum exergy loss occurs in absorber and in the HPG, which makes the absorber and HPG the important components of the double effect refrigeration system.

Rabah Gomri et al (2009) Second law comparison of single effect and double effect vapor Absorption refrigeration systems. Comparative study between single effect and double effect absorption refrigeration systems is done. He developed the computer program based on energy balances analysis of thermodynamic properties to carry out thermodynamic analysis. He reached the conclusion that for each evaporator and condenser temperature, there exist an optimum generator temperature where change in Exergy of single effect and double effect absorption refrigeration system is minimum. He showed that the COP of double effect system is all most twice the COP of single effect system but there exist a marginal difference between the Exergetic efficiency of the system.

Armando Huicochea et al (2013) Analysis of the behavior of an experimental absorption heat transformer for water purification for different mass flux rates in the Generator. The first and second laws of thermodynamics have been used to analyze the performance of an experimental absorption heat transformer for water purification. Irreversibilities, COP and exergy coefficients of performance (ECOP) were determined as function of Mass flow of hot water supplied to the generator and as function of the overall thermal specific energy consumption (OSTEC) parameter defined in this paper. The results showed that the system irreversibilities increase meanwhile the COP and the ECOP decrease with an increase of the mass flow of hot water supplied to the generator. It was also shown that the system performance is better when the production of purified water increases due to the increment of the heat recycled to the generator and evaporator.

3.1 Table -2 Summary of Literature Review on Exergy analysis

S.NO	AUTHORS	DESCRIPTION	YEAR	METHODOLOGY	FINDINGS
1	Alizadeh, S.Bahar, F.Geoola	Design and optimization of an absorption refrigeration system operated by solar energy.	1997	The effect of variation of temperatures on different component of VAS for a given Refrigeration capacity.	Higher generator temperature causes high cooling effect for smaller surface area.
2	Ravi kumar, T.S., Suganthi L, and Anand, A.Samuel.	Exergy analysis of solar assisted double effect absorption refrigeration system	1998	Detailed study of exergy variation in the solar assisted absorption system. Cycle parameters are analyzed on the basis of basis first law and second law of thermodynamics.	When quality of device declines, the availability varies linearly. The result shows the effect of maximum temperature of solar collectors on the system performance
3	Arzu Sencana, Kemal A. Yakuta, Soteris A. Kalogiro	Exergy analysis LiBr/H2O VAS was done for cooling and heating application. The exergy loss, Enthalpy, Entropy was calculated for each component of the system.	2005	Calculated the Exergy losses in the system components. The effect of heat source temperature on COP and Exergetic efficiency was computed.	COP increases slightly when increasing the heat source temperature but the Exergetic efficiency of the decreases, when the heat source temperature increase for both cooling and heating
4	Muhsin Kilic, Omer Kaynakli	Second law-based thermodynamic analysis of water- lithium bromide absorption refrigeration system	2007	The effect of different parameters such as generator temperature, absorber temperature, condenser temperature, solution circulation ratio and solution concentration etc had been investigated by these researchers on COP.	COP of the cycle increases with increasing generator and Evaporator temperatures, but decreases when condenser and absorber temperature increases.
5	Ribah Gomri, Riad Hakimi.	Second law analysis of double effect for VAS. The system consists of a second effect generator including two solution heat exchangers between the absorber and two generators.	2008	To simulate the refrigeration system by using a computer, a new set of computationally efficient Formulations of thermodynamic properties of LiBr and water solution developed is used.	Performance of the system increases with increase in low pressure Generator temperature, but decreases with increasing high pressure and TG.
7	Armando Huicochea , Wilfrido Rivera , Hiram Martínez , Javier Siqueiros, Erasmo Cadenas	Analysis of the behavior of an experimental absorption heat transformer for water purification for different mass flux rates in the Generator.	2013	Analyze the performance of an experimental absorption heat transformer for water purification. Irreversibilities, COP and exergy coefficients of performance (ECOP) were determined.	The irreversibilities Increases meanwhile the COP and the ECOP decrease with an increase of the mass flow of hot water supplied to the generator.
8	T. Avanessian M. Ameri	Energy, exergy and economic analysis of single and double effect LiBr-H2O absorption chillers.	2014	This absorption systems under different operating and climatic conditions are analyzed and compared, the effect of considering the chemical exergy of the LiBr and H2 O solution on the second law analysis of such systems.	Exergy efficiency increases with increasing the Generator or ambient air temperature decreases with increasing the evaporator temperature and changes slightly with relative humidity.
9	Omer Kaynakli, Kenan Saka Faruk Kaynakli	Energy and exergy analysis of a double effect absorption refrigeration system based on different heat sources.	2015	The VAS runs on various heat sources such as hot water, hot air and steam via High Pressure Generator (HPG). A parametric study done to find the effect on heat capacity and exergy destruction of the HPG, (COP) of the system, and mass flow rate of heat sources	With the increase of heat sources temperature, the exergy destruction also increases. The exergy destruction of the HPG increases when the condenser and the absorber temperature increase.
10	Akhilesh Arora,Manoj Dixit,S.C. Kaushik.	Computation of optimum parameters of a half effect LiBr and H2O absorption refrigeration system.	2016	The effect of low and high generator temperature, evaporator temperature, effectiveness of solution heat exchangers and difference between low and high pressure generator temperatures have been considered in computing optimum intermediate pressure.	There exists a specific generator temperature below which a half effect system ceases to work. The COP and exergetic efficiency are zero corresponding to this value.
11	R. Maryami, A.A. Dehghan	An exergy based comparative study was done on LiBr/H2O Absorption refrigeration systems from half effect to triple effect.	2017	The exergy analysis of all system components was done. The five classes are: half effect, single effect, series class of double effect, parallel class of double effect and triple effect VAS was done.	The COP and exergetic efficiency both increases from the half, single, double and triple effect refrigeration system while total exergy change decreases.

4.0 CONCLUSION

An extensive literature review has been done on LiBr and H_2O vapor absorption system. The whole study has been divided into two broad areas as mentioned above to understand the effect of different parameters on its working. The detail understanding of the entire component is required in order to increase the COP of the system and to reduce the irreversibility associated with it. The energy and exergy analysis was done for the whole cycle. It was found that the generator was more sensitive to the COP of the system. There is an optimum generator temperature at which the COP and exergy efficiency of VAS is Maximum. The result shows that the COP of the cycle increases as the generator temperature increases but to a certain limit afterwards it tends to decrease. In order to improve the performance of the system the best design of the components are necessary. This review paper will be very much helpful for the further work on the VAS working on the LiBr and Water.

REFERENCES

1.Bell, I.A., Al-Daini, A.J., Al-Ali, Habib., Abdel-Gayed, R.G., and Duckers: The design of an evaporator, absorber and thermodynamic analysis of a vapour absorption chiller driven by solar energy, World Renewable Energy Congress, (1996), pp. 657-660 .

2.W. riveraa,, r.j. romero, r. best,c.l. heard : Experimental evaluation of a single-stage heat transformer operating with the water/Carrol mixture. Energy 24 (1999) 317–326.

3.Lee, S.F., Sherif, S.A: Thermodynamic analysis of a lithium bromide/water absorption system for cooling and heating applications, International Journal of energy Research,Vol.25, (2000), pp.1019-1031.

4.M.B Arun, M.P Maiya, S.Srinivasa Murthy: Performance comparison of double effect parallel flow and series flow LiBr and H2O absorption systems, applied thermal engineering(2001)1273-1279.

5.G.A Florides S.A.Kalogiru, S.A.Tassou,L.C.Wrobel: Modeling and simulation of an absorption solar cooling system. Applied thermal engineering 21(2002) 1273-1279.

6.Y. Kaita: Simulation results of triple-effect absorption cycles, International Journal of Refrigeration 25 (2002) 999–1007.
7.G.A. Florides, S.A. Kalogirou, S.A. Tassou b, L.C. Wrobel: Design and construction of a LiBr–water absorption machine, Energy Conversion and Management 44 (2003) 2483–2508.

8.Antonio De Lucas, Marine Donate, Carolina Molero.: Experimental investigation of a vapor absorption refrigeration system, International Journal of Refrigeration, Vol. 27, (2004), pp.10-16
9.Marina Donate, Luis Rodriguez, Antonio De Lucas, Juan F. Rodrı´guez: Thermodynamic evaluation of new absorbent mixtures of lithium bromide and organic salts for absorption refrigeration machines. International Journal of Refrigeration 29 (2006) 30–35.

10.Omer Kaynakli,Muhsin Kilic; Theoretical study on the effect of operating conditions on performance of absorption refrigeration system, Energy Conversion and Management, Vol. 48, (2007), pp. 599-607.

11.Francis Agyenim, Ian Knight, Michael Rhodes: Design and experimental testing of the performance of an outdoor LiBr/H2O solar thermal absorption cooling system with a cold store, Solar Energy 84 (2010) 735–744.

12.Garousi Farshi, L., Mahmoudi, S.M.S., Rosen:Analysis of crystallization risk in double effect absorption refrigeration systems, Applied Thermal Engineering, Vol. 31(10), (2011) pp.1712-1717.

13.Saeed. Sedigh,Hamid. Saffari: Thermodynamic analysis of triple effect absorption refrigeration systems, International Journal of Energy & Technology 4 (7) (2012) 1-8

14.Zeyu Li, Jinping Liu: Appropriate heat load ratio of generator for different types of air cooled lithium bromide–water double effect absorption chiller.(2015)pp.264-273

15.A.A.V. Ochoa, J.C.C. Dutra, J.R.G. Henríquez , C.A.C. dos Santos: Dynamic study of a single effect absorption chiller using the pair LiBr/H2O, Energy Conversion and Management 108 (2016) 30–42

16.Zeyu Li, Liming Liu, Jinping Liu: Variation and design criterion of heat load ratio of generator for air cooled lithium bromide-water double effect absorption, Applied Thermal Engineering (2015)

17.Salem M. Osta-Omar and Christopher Micallef: Determination of Concentration of the Aqueous LiBr Solution in a Vapor Absorption Refrigeration System by Measurement of Electrical Conductivity and Temperature(2017)

18.Alizadeh, S.Bahar, F.Geoola,:Design and optimization of an absorption refrigeration system operated by solar energy, Solar Energy, Vol. 22, (1997), pp. 149-154.

19.Ravi kumar, T.S., Suganthi, L., and Anand, A.Samuel; Exergy analysis of solar assisted double effect absorption refrigeration system, Renewable Energy, Vol. 14(1-4), (1998), pp. 55-59

20.Sencan, A., Yakut, K.A., Kalogirou, S.A; Exergy analysis of lithium bromide/water absorption systems, Renewable Energy, Vol. 30, (2005), pp. 645-657

21.Kilic, M. and Kaynakli,:Second law-based thermodynamic analysis of water- lithium bromide absorption refrigeration system, Energy, Vol.32, (2007), pp. 1505-1512

22.Gomri, R., Hakimi,: Second law analysis of double effect vapour absorption cooler system, Energy Conversion and Management, Vol. 49(11), (2008), pp. 3343-3348

23.Armando Huicochea,Wilfrido Rivera,Hiram Martínez, Javier Siqueiros, Erasmo Cadenas: Analysis of the behavior of an experimental absorption heat transformer for water purification for different mass flux rates in the generator, Applied Thermal Engineering 52 (2013) 38-45

24.T.Avanessian, M. Ameri: Energy, exergy, and economic analysis of single and double effect LiBr-H2Oabsorption chillers, Energy and Buildings (2014)

25.Omer Kaynakli, Kenan Saka , Faruk Kaynakli: Energy and exergy analysis of a double effect absorption refrigeration system based on different heat sources, Energy Conversion and Management 106 (2015) 21–30

26.Akhilesh Arora,Manoj Dixit,S.C. Kaushik.: Computation of optimum parameters of a half effect water-lithium bromide vapour absorption refrigeration system, JTEN (2016)

27.R.Maryami, A.A. Dehghan: An exergy based comparative study between LiBr/water absorption refrigeration systems from half effect to triple effect. (2017) 103–123